AMENDMENTS TO THE SPECIFICATION

Please replace the paragraph beginning on page 1, line 19, and ending on page 2, line 5, with the following amended paragraph:

Application of the network and communication system is changed from transferring text and audio data to transferring multimedia data, so the requirement of wireless bandwidth is getting more imperative. The multicarrier code division multiple access (MC-CDMA) communication system is a method to apply the spreading technology onto the OFDM structure. The MC-CDMA allows the spreading code to be independently modified on the carrier wave by the user to decline and flatten the channel, and provides the benefit of various frequencies ~~to~~ against interference by using the first-order equalizer.

Please replace the paragraph beginning on page 2, line 7, and ending on page 3, line 1, with the following amended paragraph:

In the field of the wireless communication system, one of the most important topics is how to eliminate the decay and interference of signals, and a multi-input multi-output (MIMO) technology is disclosed recently. Pluralities of antennas are installed at both terminals of the wireless transmission, so the spectrum efficiency and transmission reliability can be obviously improved, and the diversity gain can be provided. In 1998, the BLAST (Bell Laboratories layered space-time) technology which is ~~an~~ a structure of MIMO ~~is~~ was disclosed by Foschini et al. (Wireless Personal Commun., vol.6, pg.315-

335). The spatial multiplexing function in the point-to-point narrow-band communication can be achieved with this technology without increasing transmitting power and system bandwidth. The spatial multiplexing function can transmit different data streams at pluralities of antennas simultaneously with the independent and parallel spatial channels, and get more effective spectrum of the communication system.

Please replace the paragraph beginning on page 4, line 23, and ending on page 5, line 13, with the following amended paragraph:

According to the claimed invention, a structure of a MIMO MC-CDMA communication system is disclosed. The transmitter comprises: a de-multiplexer for receiving a user's data and outputting the data divided into a plurality of parallel data streams; a plurality of space time block encoders individually receiving the parallel data streams of the de-multiplexer and outputting the data streams after encoding; a plurality of space-path spreaders receiving outputted data from the space time block encoders and outputting received data after spreading with a pre-designed space-path spreading code; and a plurality of transmit antennas, each transmit antenna receives outputted data from each space-path spreader and ~~transmitting~~ transmits received data through multiple paths.

Please replace the paragraph beginning on page 5, line 15, and ending on page 6, line 6, with the following amended paragraph:

The present invention also discloses a receiver applied on the above-mentioned MIMO MC-CDMA communication system. The receiver comprises: a plurality of receive antennas for receiving data transmitted by the transmit antennas; a plurality of matched filters individually receiving data received by the receive antennas and despreading it in accordance with the space-path spreading code; a space-time linear combiner receiving data dispread by the matched filters and outputting received data after combining; a BLAST detector receiving data outputted by the space-time linear combiner, separating mutually interfering ~~signal~~ signals from the multiple transmit antennas, obtaining diversity gain, and outputting operated data; and a multiplexer receiving data ~~outputted by~~ from the BLAST detector and outputting data after multiplexing.

Please replace the paragraph on page 6, lines 8-17, with the following amended paragraph:

The present invention further discloses a MIMO MC-CDMA communication method. The step of transmitting data comprises: simultaneously transferring ~~a~~ transmitting data ~~to~~ into a plurality of parallel data streams; space time block encoding each parallel data stream; spreading the encoded data streams with a pre-designed space-path spreading code; and collecting the spread parallel data streams, transferring to a plurality of transmit antennas, and transmitting data with the transmit antennas through ~~a~~ multiple paths.

Please replace the paragraph beginning on page 6, line 19, and ending on page 7, line 5, with the following amended paragraph:

The step of receiving data of the MIMO MC-CDMA communication method comprises: receiving data transmitted by the transmit antennas through a plurality of receive antennas; despreading data received by the receive antennas through a plurality of corresponding matched filters in accordance with the pre-designed space-path spreading code; combining the dispread data with a linear combiner; and separating mutually interfering ~~signal~~ signals from the combined data with a BLAST detector, and outputting data after multiplexing it with a multiplexer.

Please replace the paragraphs beginning on page 8, line 12, and ending on page 9, line 12, with the following amended paragraph:

The claimed structure of a MIMO MC-CDMA communication system is shown in Figs.1(a) and 1(b). Fig.1(a) is a schematic diagram of a transmitter of this system, Fig.1(b) is a schematic diagram of a receiver of this system, and this structure is constructed on the multiple paths of frequency setting. The transmitter of the base station has N_t transmit antenna 16 providing K users to transmit data simultaneously. As shown in Fig.1(a), the data streams of each user are processed by a de-multiplexer 10 to produce LN_t substreams, and the substreams can be divided into L groups of parallel data streams with N_t symbols and outputted from the de-multiplexer 10. The data ~~steam~~ streams of

~~user~~ users can be shown as $d_k(i)$, wherein $k = 1,2,\ldots,K$ means K users. After processing by the de-multiplexer 10, the substreams can be shown as $d_{k,p}^{(n_t)}(i) = d_k(N_t(i+p-1)+n_t-1)$, wherein $n_t = 1,2,\ldots,N_t$ ~~、~~, $p = 1,2,\ldots,L$, and L is the path length (the unit is chip). The L groups of parallel data streams ~~outputted~~ output by the de-multiplexer are space-time block coded with the L space time block coders (STBC) 12, and in the coded L data streams, the symbol of each data stream has the same space time block coding structure. That means that the symbols with the same N_t are related complex conjugation multiplying a minus sign. The space time block coding technology can provide various space to diversify and obtain better chain quality.

Please replace the paragraph beginning on page 9, line 14, and ending on page 10, line 12, with the following amended paragraph:

Then, the coded parallel data streams are individually passed through the space-path spreader 14. The data streams are spread with the pre-designed space-path spreading codes $\mathbf{t}_{k,p}$ to anticipatively suppress the multiple access interference (MAI) and anticipatively equalize the multiple paths. After spreading, the $n_{t\,\text{th}}$ data stream of each group of the substreams are added and transmitted to the $n_{t\,\text{th}}$ antenna. The transmission signal on the N_t transmit antenna is $\mathbf{s}(t) = [s^{(1)}(t), s^{(2)}(t), \ldots, s^{(N_t)}(t)]^T$, wherein $s^{(n_t)}(t) = \sum_{k=1}^{K} s_{k,i}^{(n_t)}(t)$. In the MC-CDMA system, the transmission signal $s_{k,i}^{(n_t)}(t)$ of the

i_{th} data symbol transmitted by the k_{th} user through the n_t th transmit antenna 16 can be shown as:

$$s_{k,i}^{(n_t)}(t) = \sum_{m=0}^{M-1} \sum_{p=1}^{L} t_{k,p}(m) d_{k,p}^{(n_t)}(i) \exp\{j2\pi m \frac{t}{T_b}\} \qquad (1)$$ ~~wh~~

~~erein~~ wherein, $t \in [iT_b, (i+1)T_b]$, T_b is symbol interval, $t_{k,p}(m)$ is the $(m+1)_{th}$ $\mathbf{t}_{k,p}$, $d_{k,p}^{(n_t)}(i)$ is i_{th} data symbol with the average zero and the variation P_T/N_t, P_T is the total transmission energy average. The transmission path has L separated Rayleigh decay path (L<< M), and for simplifying the analysis, if the path delay spread interval of all users are the same, a guard time T_G can be inserted before transmitting $s_{k,i}^{(n_t)}(t)$ to reduce the interference between symbols.

Please replace the paragraph beginning on page 12, line 2, and ending on page 14, line 1, with the following amended paragraph:

At the receiver, the detection of symbols can be achieved by using the matched filter 20, the space-time linear combiner 22, and the BLAST detector 24, and outputted by the ~~multiplexer26~~ multiplexer 26. Please refer to Fig.1(b), after the receive antenna 18 of the mobile station receives the data signals from the transmitter, the guard time of the received data is removed in advance if the received data has been added to the guard time or processed with the inverse fast Fourier transform (IFFT), and reversing the data to the

frequency domain with FFT. The transmitter utilizes the space-path spreading codes to suppress the multiple access interference (MAI) and equalize the paths, so the receiver only needs a simple matched filter 20 to dispread data. The data received by groups of the receive antennas 18 of the receiver is dispread by groups of matched filters, and these filters have the space-path spreading codes corresponding to the receiver. The matched filter 20 of the q_{th} mobile station can be shown in $\mathbf{c}_q$ with length M, and the outputting data of the $m_{r\,th}$ receive antenna 18 of the matched filters 20 corresponding to the mobile station can be shown as:

$$
\begin{aligned}
y_q^{(m_r)}(i) &= \mathbf{c}_q^H \mathbf{x}_q^{(m_r)}(i) \\
&= \sum_{k=1}^{K} \sum_{n_t=1}^{N_t} \sum_{p=1}^{L} \sum_{l=1}^{L} \alpha_{q,l}^{(m_r,n_t)} d_{k,p}^{(n_t)}(i) \mathbf{c}_{q,l}^H \mathbf{t}_{k,p} + \tilde{n}_q^{(m_r)}(i) \qquad (7)
\end{aligned}
$$

wherein $\mathbf{c}_{q,l} = \mathbf{c}_q \odot \overset{*}{\mathbf{w}}_{q,l}$ is the despreading vector multiplies the phase shift vector of the l_{th} path, and $\tilde{n}_q^{(m_r)}(i) = \mathbf{c}_q^H \mathbf{n}_q^{(m_r)}(i)$ means the noise. The pre-designed space-path spreading codes can effectively suppress the multiple access interference and symbol interference by using the space-path spreading codes to remove the noise, and is shown as:

$$
\begin{aligned}
&\mathbf{c}_{q,l}^H \mathbf{t}_{k,p} = 1, \qquad q = k, l = p \\
&\mathbf{c}_{q,l}^H \mathbf{t}_{k,p} = 0, \qquad otherwise \qquad (8)
\end{aligned}
$$

wherein $l = 1,2,\ldots,L$, $p = 1,2,\ldots,L$, $k = 1,2,\ldots,K$. Solving the equation (8) can obtain:

$$\mathbf{T} = \mathbf{C}(\mathbf{C}^H \mathbf{C})^{-1} \qquad (9)$$

$\mathbf{T} = [\mathbf{t}_{1,1},\ldots,\mathbf{t}_{1,L},\ldots,\mathbf{t}_{K,1},\ldots,\mathbf{t}_{K,L}]$ is the space-path spreading codes matrix, $\mathbf{C} = [\mathbf{C}_1, \mathbf{C}_2, \ldots, \mathbf{C}_K]$ is the "phase shift" spreading codes matrix, and

$\mathbf{C}_k = [\mathbf{c}_{k,1}, \mathbf{c}_{k,2}, \ldots, \mathbf{c}_{k,L}]$ is the $M \times L$ codes matrix of the k_{th} user which is used to show the valid feature wave in the path delay spreading interval. If C has a complete column rank, namely $M \geq KL$, the suppressing effect will be greater. When M is fixed, amount of the valid user is only limited by L, and the maximum amount of valid user is:

$$K_{\max} = \left\lfloor \frac{\mathrm{M}}{\mathrm{L}} \right\rfloor \tag{10}$$

Please replace the paragraph beginning on page 14, line 12, and ending on page 15, line 13, with the following amended paragraph:

After processing by the matched filter 20, equation (12) can be explained as an equivalent narrow-band MIMO system, which has LN_t inputs (N_t continuous symbols) and M_r outputs (behind the matched filter 20). A flat decay channel inside it has the decay gain $h_{q,l}^{(m_r,n_t)}$ and the additional noise. A continuous N_t symbols $y_q^{(m_r)}(i+n_t-1)$, whose $y_{q,n_t}^{(m_r)}(i) = y_q^{(m_r)}(i+n_t-1)$ and $m_r = 1,2,\ldots,M_r, n_t = 1,2,\ldots,N_t$, is shown in vector form:

$$\begin{aligned}\mathbf{y}_q(i) &= [y_{q,1}^{(1)}(i),\ldots,y_{q,N_t}^{(1)}(i), y_{q,1}^{(2)}(i),\ldots,y_{q,N_t}^{(2)}(i),\ldots,y_{q,1}^{(M_r)}(i),\ldots,y_{q,N_t}^{(M_r)}(i)]^T \\ &= \mathbf{H}_q \mathbf{d}_q(i) + \tilde{\mathbf{n}}_q(i)\end{aligned} \tag{13}$$

wherein $\mathbf{d}_q(i) = [d_{q,1}^{(1)}(i),\ldots,d_{q,1}^{(N_t)}(i),\ldots,d_{q,L}^{(1)}(i),\ldots,d_{q,L}^{(N_t)}(i)]^T$, $\tilde{\mathbf{n}}_q(i)$ is the noise vector, and the compound channel matrix $\mathbf{H}_q$ of the q_{th} mobile station is:

$$\mathbf{H}_q = \begin{bmatrix} \mathbf{H}_{q,1}^{(1)} & \cdots & \mathbf{H}_{q,L}^{(1)} \\ \vdots & \ddots & \vdots \\ \mathbf{H}_{q,1}^{(M_r)} & \cdots & \mathbf{H}_{q,L}^{(M_r)} \end{bmatrix} \quad (14)$$

$\mathbf{H}_{q,l}^{(m_r)}$ is the $N_t \times N_t$ sub matrix of $\mathbf{H}_q$, $\mathbf{H}_q$ has the complete column rank when $L \le M_r$.

The BLAST detector 24 can be applied, for example: when $N_t = 2$

$$\mathbf{H}_{q,l}^{(m_r)} = \begin{bmatrix} h_{q,1}^{(m_r,1)} & h_{q,1}^{(m_r,2)} \\ h_{q,1}^{(m_r,2)} & -h_{q,1}^{(m_r,1)} \end{bmatrix} \quad (15)$$

which has a channel structure similar to that of STBC. With the compound channel, a BLAST detector 24 can be used in a N_t symbol cycle to decode LN_t substreams, and a multiple gain L is obtained. On the other hand, the transmission diversity gain can be achieved with multiple transmit ~~antenna~~ antennas transmitting the same N_t symbols.

Please replace the paragraph beginning on page 15, line 15, and ending on page 16, line 9, with the following amended paragraph:

With assistance of linearly combining $\mathbf{y}_q(i)$ and the compound channel matrix $\mathbf{H}_q$, the adequate statistics vector $\mathbf{z}_q(i)$ with LN_t dimensions can be obtained as:

$$\mathbf{z}_q(i) = \mathrm{Re}\{\mathbf{H}_q^H \mathbf{y}_q(i)\} = \mathbf{F}_q \mathbf{d}_q(i) + \mathrm{Re}\{\mathbf{H}_q^H \tilde{\mathbf{n}}_q(i)\} \quad (16)$$

wherein $\mathbf{F}_q = \mathrm{Re}\{\mathbf{H}_q^H \mathbf{H}_q\}$ is a $LN_t \times LN_t$ matrix, a $N_t \times N_t$ diagonal matrix $\rho_{q,l}\mathbf{I}_{N_t}$ locates on its l_{th} diagonal block, $l = 1,2,\ldots,L$, and

$$\rho_{q,l} = \sum_{m_r=1}^{M_r} \sum_{n_t=1}^{N_t} | h_{q,l}^{(m_r,n_t)} |^2 \qquad (17)$$

shows N_tM_r total diversity gain (N_t comes from the transmitter, M_r comes from the receiver). In view of the equation (16), this system can have LN_t inputs, LN_t outputs and a MIMO flat decay channel. Hence, the LN_t substreams can be detected by using the method of combining MMSE and OSIC when processing the BLAST (please refer to the journal published by Foschini in IEEE J. Select. Areas Commun, Nov. 1999, vol. 17, no. 11, page 1841-1852).

Please replace the paragraph beginning on page 16, line 11, and ending on page 17, line 6, with the following amended paragraph:

Under the structure of Figs.1(a) and 1(b), the total diversity gain of the MC-CDMA communication system is N_tM_r, and when $L \le M_r$, the transmission speed is L (namely multiple gain) and this system can further adjust the multiple gain and the total diversity gain. Please refer to Fig.2, in this embodiment, the substreams with STBC processed are transmitted to the corresponding space-time spreader with two substreams in one group. When $L \le M_r / 2$, the total diversity gain of this system is $N_tM_r/2$, and the transmission speed is 2L. Under the structure of Fig.3, the outputted data of each STBC is transmitted to two ~~space=time~~ space-time ~~spreader~~ spreaders. When $L \le 2M_r$, the total diversity gain of this system is $2N_tM_r$, and the transmission speed is L/2. Similarly, by

adjusting the relationship of the STBC and the space-time spreader, the different diversity gains and transmission speeds are obtained. Hence, the MC-CDMA communication system of the present invention can be suitably selected in space multi-work or variance according to the requirement.

Please replace the paragraph on page 17, lines 8-17, with the following amended paragraph:

In contrast to the prior art, the present invention discloses a space time block coding technology combined with the suitable space-path spreading codes, so that the MIMO MC-CDMA communication system can have better ability of space multi-work and space variance to accomplish a greater spectrum efficiency and chain quality. In addition, the spectrum efficiency and the chain quality can be further adjusted according to actual ~~requirement~~ requirements, and not only improves the system efficiency but also provides various applications.